must be exercised to ensure that the cured excess material 61 does not interfere with the demolding process, and to ensure that the lens is not damaged during release.

Figures 18 and 19 show an alternative configuration for posterior mold 21 which is particularly suited for dry release of lens 72. As shown in Figure 18, posterior mold 21 includes retaining means for retaining the cured excess 61, the retaining means being in the form of groove 75 at a point adjacent annulus 47 and in the area of receptacle 59. As shown in Figures 18 and 19, groove 75 becomes filled with excess lens material while the lens material is in the liquid or semi-liquid state. When the lens material is cured, groove 75 retains the cured excess material thereby to ensure that the excess is retained with the posterior mold 21 during the disassembly step (step S9). Advantageously, this ensures that the cured excess material does not interfere with the lens demolding process, whether that process is performed through hydration or through dry release.

While Figures 18 and 19 depict the retaining means as a groove, other forms are possible. Thus, the retaining means may take the form of plural holes in posterior mold 21, or a foot extending from posterior mold 21 into receptacle 59, or simply a roughened surface texture for the posterior mold. Likewise, if it is desired for the cured lens to remain with the posterior mold rather than the anterior mold, then retaining means may be provided on the anterior mold instead.

Figure 20 illustrates a first alternative embodiment of the invention in which centering means is provided by vertically extending cylindrical walls 24' and 44'. In all other respects, the embodiment of Figure 20 is substantially similar to that described above and a detailed discussion thereof is omitted for the sake of brevity.

Figures 21 to 24 illustrate a second alternative embodiment of the present invention which uses a taper-lock clamping means wherein it is not necessary to externally clamp the assembled mold during curing. Superficially, the embodiment of Figures 20 through 23 resembles that of Figures 1 through 19 and accordingly similar reference numbers have been used. Thus, in Figure 21, posterior mold 121 includes upstanding cylindrical shell 126, top flat 127, the reverse side 129 of posterior mold cavity defining surface 146, shoulder 140, taper 144, reverse 145, posterior mold defining surface 146, and annulus 147. Anterior mold 120 includes cylindrical base 122, tapered head 124, anterior mold cavity defining surface 125, inwardly sloping area 149, collar 150, receptacle forming area 151, rim 152, and right cylindrical wall 154.

In this embodiment, flanges 156 and 157 are provided for posterior mold 121 and anterior mold 120, respectively. Such flanges increase the rigidity of the mold sections and facilitate mechanical manipulation and may, accordingly, also be used in other of the above-described embodiments.

In Figure 21, the taper angle for tapers 144 and 124, and the relative diameters of the molds in the

r gi n f tapers 124 and 144, are s lected so that the anterior and posterior molds lock together under action of the taper. Thus, for example, taper 144 is selected at an angle of 2 1/2 degrees from vertical while taper 124 is selected at an angle of 3 degrees from vertical. Accordingly, as shown in Figure 22, the inner extremity of base 141 initially contacts the surface of taper 124 at a point 158 before rim 152 contacts annulus 147. Further downward travel of posterior mold 121 with respect to anterior mold 120 causes the rim 152 to seat against annulus 147 and causes tapers 124 and 144 to lock relative to each other, as shown in Figure 23. In the preferred embodiment, lock is achieved after a downward travel, or "taper interference," of about 75 microns. The downward and outward compressive forces caused by the locking action of the tapers cause cylindrical shell 126 to pivot outward around shoulder 140 thereby generating a downward sealing force. Straightforward analysis, for example, finite element methods, yields the amount of taper lock compressive force needed to generate a downward sealing force equivalent to that in the case of the first embodiment. In the embodiment illustrated in Figure 21 through 24, it has been found that 15 to 25 pounds of closure force yields a 35 pound sealing or clamping force and ensures that the mold sections are locked.

In like manner to that in the first embodiment, the assembled mold with lens material 160 in place is subjected to curing. The combination of the sealing force generated by downward and outward compressive forces from the taper lock with the vacuum force caus d by shrinkage is ad quate to ensure that rim

152 and annulus 147 are relativ ly d f rm d so as t accommodate shrinkage during curing. Accordingly, clamping assemblies may be eliminated although they may, of course, still be used. It has been found that after curing, surface 140 and flange 156 tend to pivot upward around shoulder 140, as shown by the dot, dash line in Figure 24, in an apparent reaction to the relative deformation of rim 152 and annulus 147.

After curing, steps S9 through S12 of Figure 7 are performed as before with respect to the first embodiment of the invention whereby a lens having a finished edge with any desired shape may be formed.

The foregoing has been provided so that the nature of the invention may be understood easily. It should, however, be apparent that modifications of the foregoing embodiments may be made without departing from the nature and scope of the invention. For example, it is possible to provide the first described embodiment of the invention with unequal taper angles for tapers 24 and 44 since these tapers are intended simply to provide alignment and centering and not necessarily to provide any taper lock force as in the second alternative embodiment. It is also possible to provide the second alternative embodiment with retaining means such as that described above with respect to the first embodiment. Accordingly, the scope of the invention should not be limited to the specifics described above but instead should be measured with respect to the appended claims.

WHAT IS CLAIMED IS:

1. A lens molding method comprising the steps of:

depositing lens material in a first mold section;

seating a second mold section adjacent the first mold section so as to define a mold cavity sealed at the edge thereof, with excess lens material being received adjacent the seal;

curing the lens material from a liquid or semi-liquid state to a solid or semi-solid state;

accommodating, during said curing step, shrinkage in the lens material by relatively deforming a rim of one of said first and second mold sections and a deformable mating surface on the other of said first and second mold sections;

forming the lens edge at the point of deformation of the rim and the mating surface.

2. A method according to Claim 1, wherein the amount of lens material deposited in said depositing step is metered such that excess lens material is deposited in the first mold section.

3. The method of claim 1 wherein the excess lens material is confined adjacent to the seal by a confining means.

4. A method according to Claim 1, further comprising the step of clamping said first and second mold sections during said curing step.

5. The method of claim 4 wherein the clamping force is sufficient to seal the mold cavity without excessive deformation.

6. The method of claim 5 wherein the clamping force is within the range of about 20-40 pounds.

7. The method of claim 4 wherein the first and second mold sections are clamped by external clamping means.

8. The method of claim 7 wherein the clamping force is maintained at a constant level throughout curing of the lens material.

9. The method of claim 4 wherein the first and second mold sections are clamped by taper-lock clamping means.

10. A method according to Claim 1, further comprising the step of disassembling the first and second mold sections such that the cured lens remains with one of said first and second mold sections.

11. The method of claim 10 wherein the mold sections are formed from different materials such that the cured lens preferentially remains on one of the mold sections after disassembly of the mold sections.

12. A method according to Claim 10, wherein excess lens material is retained in the other of said first and second mold sections.

13. A method according to Claim 10, further comprising the step of hydrating the molded lens.

14. A method according to Claim 1, further comprising the step of centering the first mold section with respect to the second mold section during said seating step.

15. A method according to Claim 14, wherein said centering step comprises the step of inserting a generally cylindrical shell of one of said first and second mold sections into a correspondingly shaped generally cylindrical shell of the other of said first and second mold section.

16. A method according to Claim 15, wherein the cylindrical shells are tapered and the tapers are substantially equal.

17. A method according to Claim 15, wherein the cylindrical shells are tapered and the tapers are different.

18. A method according to Claim 10, wherein the rim is defined by the corner of a right cylindrical wall in the mold cavity.

19. A contact lens made according to the method of any one of Claims 1 to 18.

20. A mold section for molding a lens, said mold section comprising a rigid, generally spherical mold cavity defining surface that includes a central optical zone, said mold section having a reversely angled deformable mating surface adjacent the mold

cavity defining surface and centering means depending therefrom.

21. A mold section according to Claim 20, further including a pressure receiving surface for receiving clamping pressure and distributing the pressure uniformly.

22. A mold section according to Claim 20, wherein said centering means comprises a shoulder depending from said deformable mating surface and a generally cylindrical shell.

23. A mold section according to Claim 22, wherein said cylindrical shell is tapered.

24. A mold section according to Claim 20, wherein said deformable mating surface comprises an annulus.

25. A mold section according to Claim 24, wherein said annulus is radiused.

26. A mold section according to Claim 20, wherein said mold section is constructed of a material having a hardness of approximately from Shore D 50 to Rockwell M 110.

27. A mold section according to Claim 26, wherein said mold section is constructed of a material having a hardness of approximately from Shore D 65 to Rockwell M 65.

28. A mold secti n according to Claim 27, wherein said mold section is formed from polypropylene.

29. A mold section for molding a lens, said mold section comprising a rigid, generally spherical mold cavity defining surface having a central optical zone, said mold cavity defining surface including a right cylindrical wall whose corner defines a rim at the periphery of the mold cavity defining surface, and depending centering means.

30. A mold according to Claim 29 further comprising a collar surrounding the rim.

31. A mold section according to Claim 29, wherein said centering means comprises a generally cylindrical base and a tapered head.

32. A mold section according to Claim 29, wherein said mold is formed of a material having a hardness of approximately from Shore D 70 to Rockwell M 120.

33. A mold section according to Claim 32, wherein said mold is formed of a material having a hardness of approximately from Shore D 80 to Rockwell M 110.

34. A mold section according to Claim 33, wherein said mold section is formed of PVC.

35. A mold assembly comprising:

first and second mold sections having respective first and s cond mold cavity defining

surfaces, said first mold cavity d fining surfac terminating in an encircling peripheral rim and said second mold cavity defining surface terminating in a deformable peripheral mating surface disposed at a diameter that corresponds to said peripheral rim; and

cooperating centering means provided for each of said first and second mold sections.

36. A mold assembly according to Claim 35, wherein said mating surface is an annulus.

37. A mold assembly according to Claim 36, wherein said annulus is radiused.

38. A mold assembly according Claim 35, wherein said first mold section is formed of a material different from said second mold section.

39. A mold assembly accordingly to Claim 38, wherein said second mold section has a hardness of approximately from Shore D 50 to Rockwell M 110 and said first mold section has a hardness of approximately from Shore D 70 to Rockwell M 120.

40. A mold assembly according to Claim 39, wherein said second mold section has a hardness of approximately from Shore D 65 to Rockwell M 65 and said first mold section has a hardness of approximately from Shore D 80 to Rockwell M 110.

41. A mold assembly according to Claim 40, wherein said second mold section has a hardness of appr ximately Shor D 75 and said first mold s ction has a hardn ss of appr ximat ly Shore D 87.

42. A mold assembly according to Claim 35, wherein said centering means includes a first cylindrical shell depending from said rim and a second cylindrical shell engagable with the first cylindrical shell depending from said mating surface.

43. A mold assembly according to Claim 42, wherein said first and second cylindrical shells are tapered.

44. A mold assembly according to Claim 43, wherein said first and second cylindrical shells have the same taper.

45. A mold assembly according to Claim 43, wherein the tapers lock the first and second mold sections.

46. A mold assembly according to Claim 42, wherein the cylindrical shell of one of said first and second mold section has a stepped diameter and the other of said first and second mold sections has an inwardly sloped surface adapted to interact with the stepped diameter.

47. A mold assembly according to Claim 35, wherein said mating surface is reversely angled from said second mold cavity defining surface.

48. A mold assembly according to Claim 35, wherein said first and second mold cavity defining surfac s define a rigid mold cavity having a central ptical zon .

49. A mold assembly according to Claim 35, wherein one of said first and second mold sections has greater affinity for cured lens forming material than that of the other.

50. A mold assembly according to claim 49, wherein one of said first and second mold sections includes confining means.

51. A mold assembly according to Claim 49, wherein the other of said first and second mold sections includes retaining means.

52. A mold assembly according to Claim 49, wherein said one of said first and second mold sections having greater affinity is formed from PVC and the other of said first and second mold sections is formed from polypropylene.

53. A mold assembly according to Claim 35, wherein said first mold section further comprises a collar surrounding the peripheral rim.

54. A mold assembly comprising:

an anterior mold having a rigid anterior mold cavity defining surface which terminates in an encircling peripheral rim defined by the corner of a right cylindrical wall and an outwardly extending flange; and

a posterior mold having a rigid posterior mold cavity defining surface which terminates in a reversely angled deformable peripheral annulus that is disposed at a diameter that corresponds to said peripheral rim;

wherein a rigid mold cavity is defined by said anterior and posterior mold cavity defining surfaces, said mold cavity having a generally spherical surface including a central optical zone; and

wherein said posterior mold has a hardness of approximately from Shore D 50 to Rockwell M 110 and said anterior mold has a hardness of approximately from Shore D 70 to Rockwell M 120.

55. A mold assembly according to Claim 54, wherein said annulus is radiused.

56. A mold assembly according to Claim 54, wherein said posterior mold is relatively more deformable than said anterior mold.

57. A mold assembly according Claim 56, wherein said posterior mold is formed of a material different from said anterior mold.

58. A mold assembly according to Claim 54, wherein said posterior mold has a hardness of approximately from Shore D 65 to Rockwell M 65 and said anterior mold has a hardness of approximately from Shore D 80 to Rockwell M 110.

59. A mold assembly according to Claim 58, wherein said posterior mold has a hardness of approximately Shore D 75 and said anterior mold has a hardness of approximately Shore D 87.

60. A mold assembly according to Claim 54, further comprising complementary centering means

respectively provided for each of said posterior and anterior molds.

61. A mold assembly according to Claim 60, wherein said centering means includes a first cylindrical shell depending from said rim and a second cylindrical shell engagable with the first cylindrical shell and depending from said annulus.

62. A mold assembly according to Claim 61, wherein said first and second cylindrical shells are tapered.

63. A mold assembly according to Claim 62, wherein said first and second cylindrical shells have the same taper.

64. A mold assembly according to Claim 62, wherein the tapers lock the posterior and anterior molds.

65. A mold assembly according to Claim 61, wherein the cylindrical shell of one of said posterior and anterior molds has a stepped diameter and the other of said posterior and anterior molds has an inwardly sloping surface adapted to interact with the stepped diameter.

66. A mold assembly according to Claim 54, wherein said annulus is reversely angled from said posterior mold cavity defining surface.

67. A mold assembly according to Claim 54, wherein one of said anterior and posterior molds has

great r affinity for cured lens forming a material than that of the other.

68. A mold assembly according to claim 67 wherein the one of said first and second mold sections includes confining means.

69. A mold assembly according to Claim 67, wherein the other of said first and second mold sections includes retaining means.

70. A mold assembly according to Claim 69, wherein said one of said anterior and posterior molds having greater affinity is formed from PVC and the other of said anterior and posterior molds is formed from polypropylene.

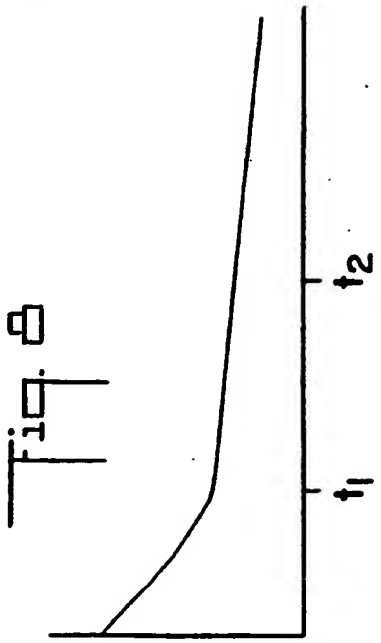


Fig. 8

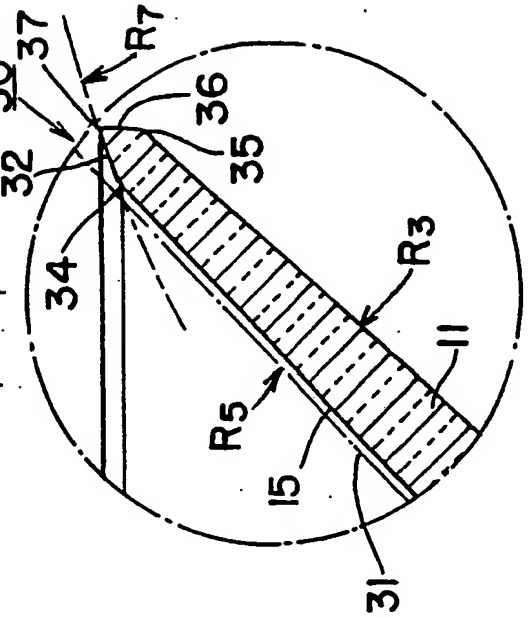


Fig. 3

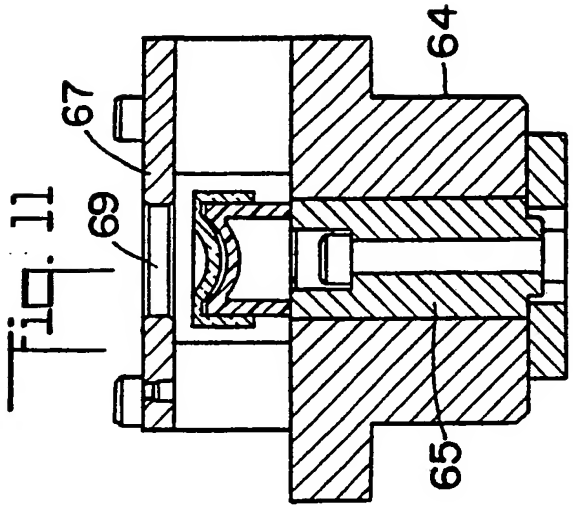


Fig. 11

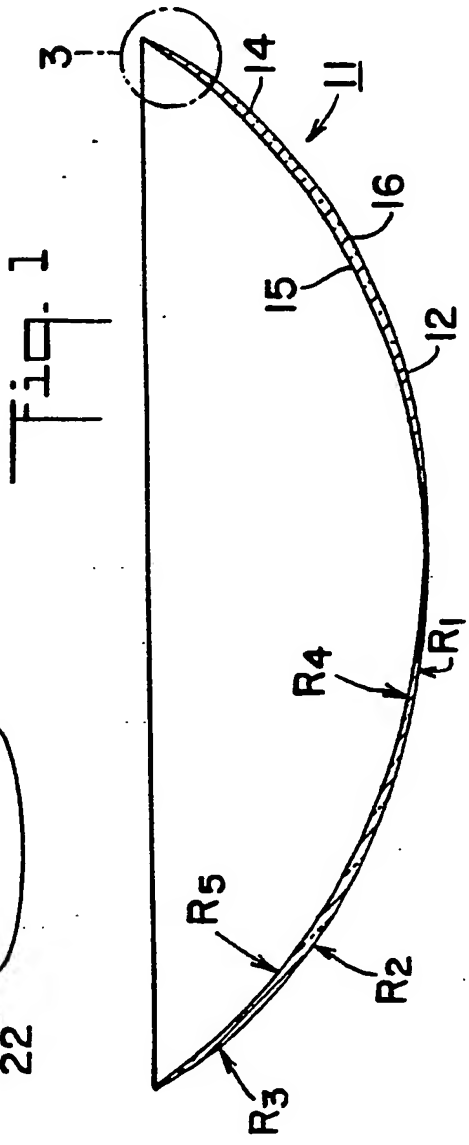


Fig. 1

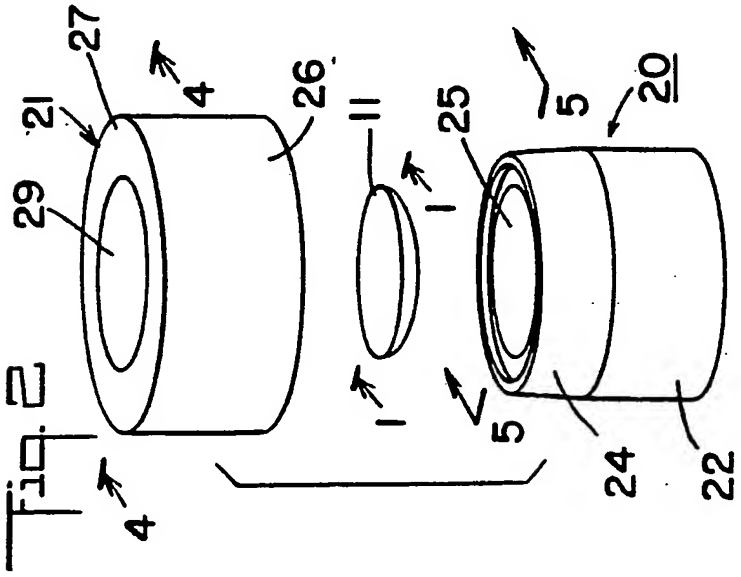


Fig. 2

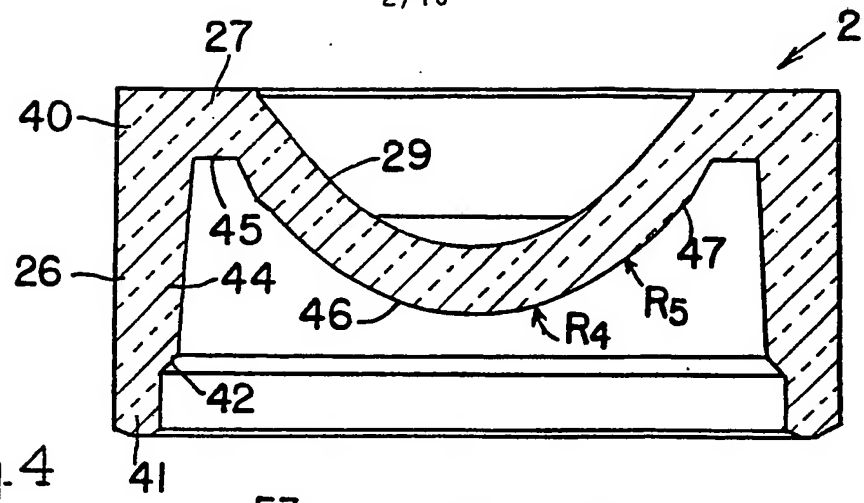


Fig. 4

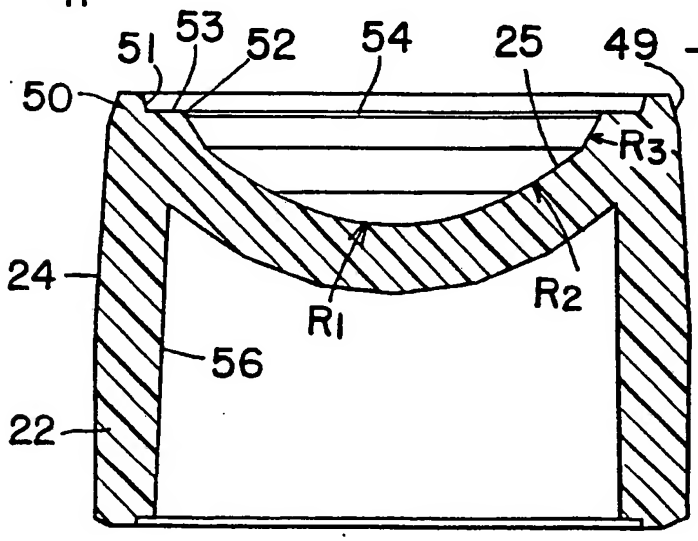


Fig. 5

Fig. 6

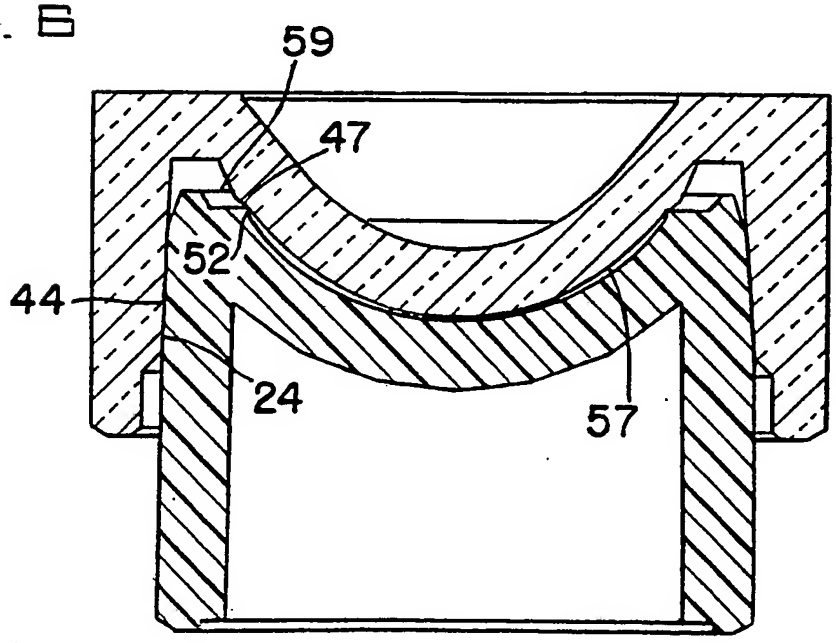


Fig.7

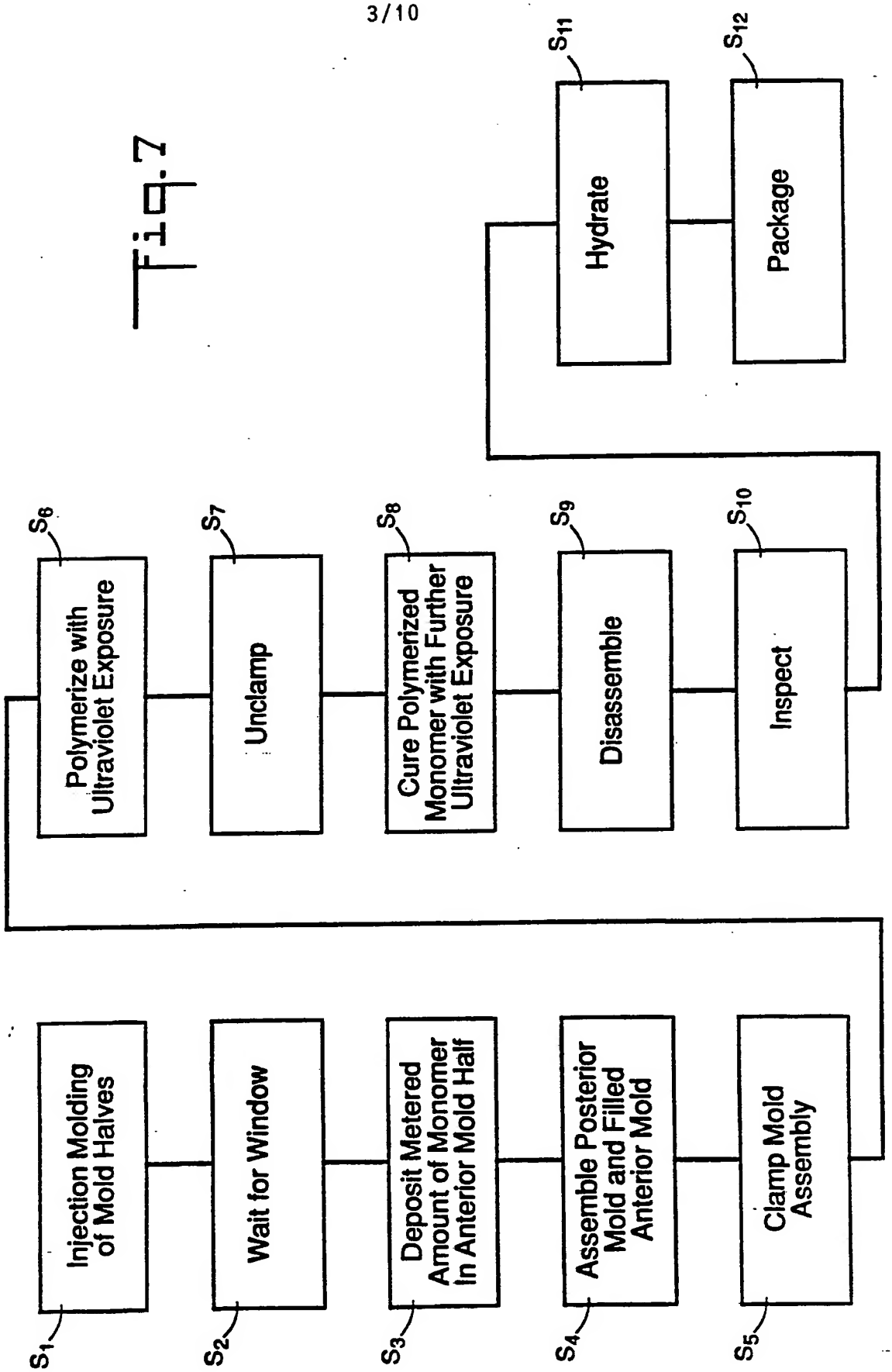

Injection Molding of Mold Halves
S1
Wait for Window
S2
Deposit Metered Amount of Monomer In Anterior Mold Half
S3
Assemble Posterior Mold and Filled Anterior Mold
S4
Clamp Mold Assembly
S5
Polymerize with Ultraviolet Exposure
S6
Unclamp
S7
Cure Polymerized Monomer with Further Ultraviolet Exposure
S8
Disassemble
S9
Inspect
S10
Hydrate
S11
Package
S12

Fig. 9

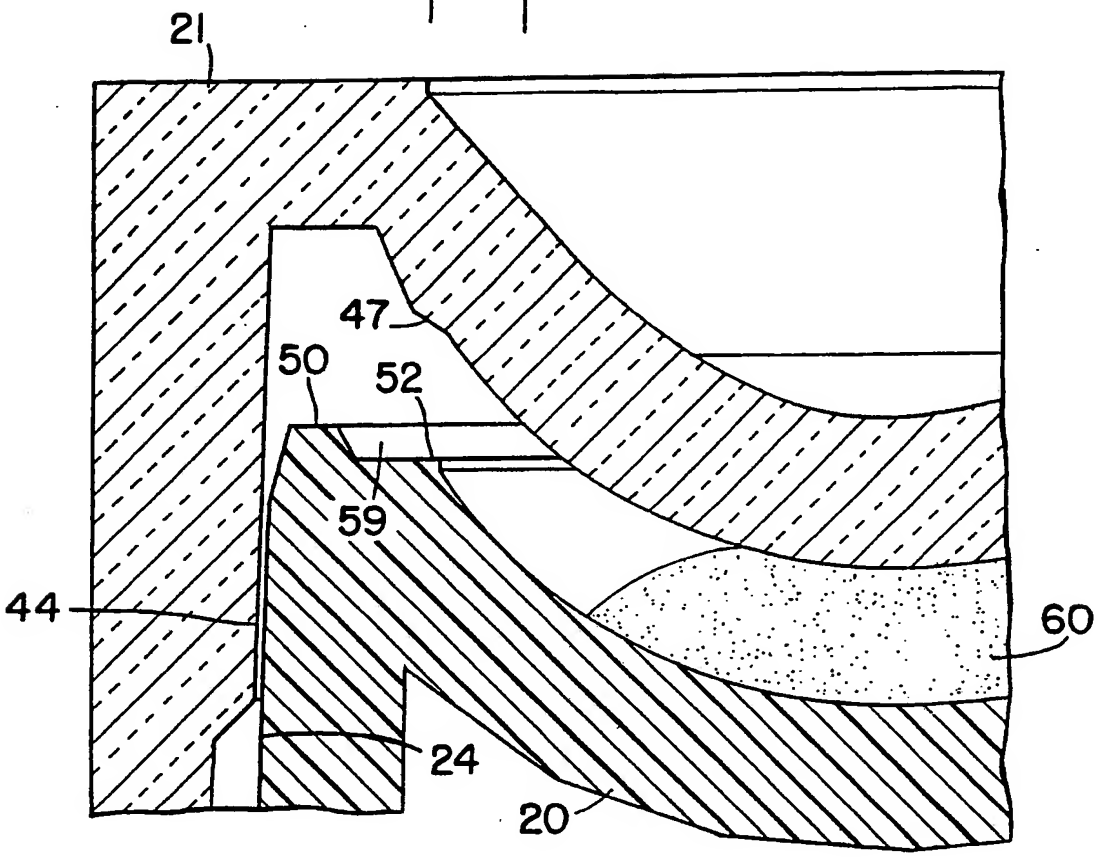


Fig. 10

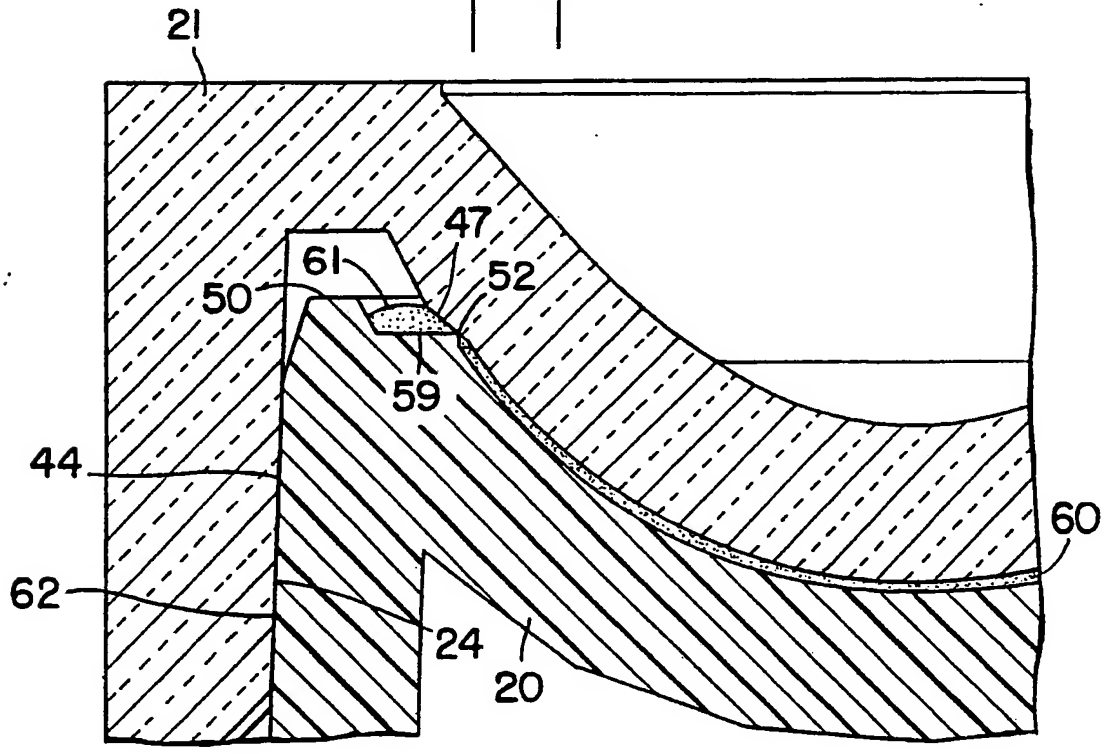


Fig. 13

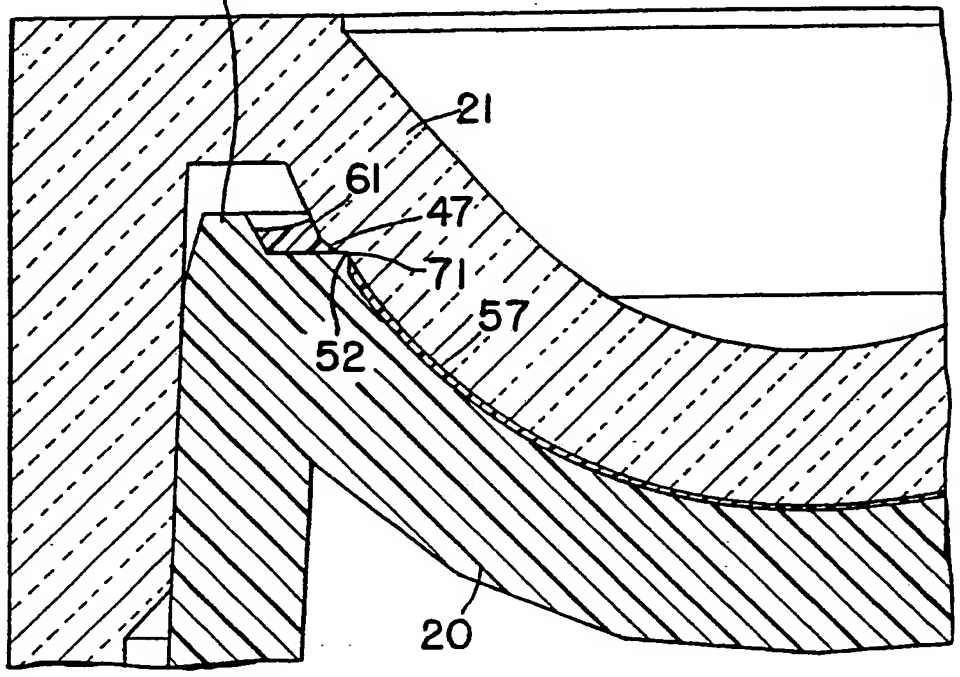


Fig. 14

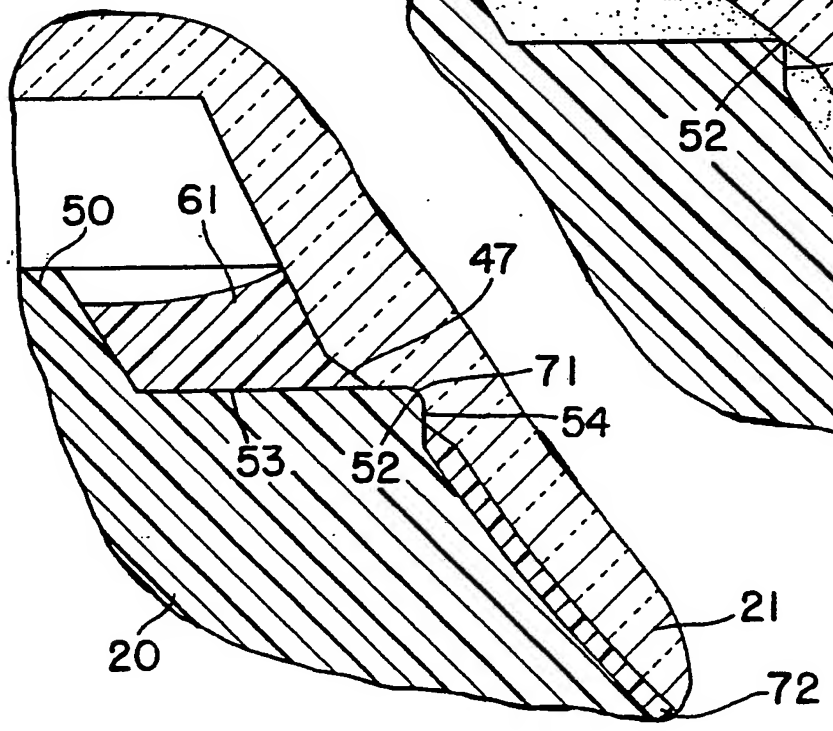
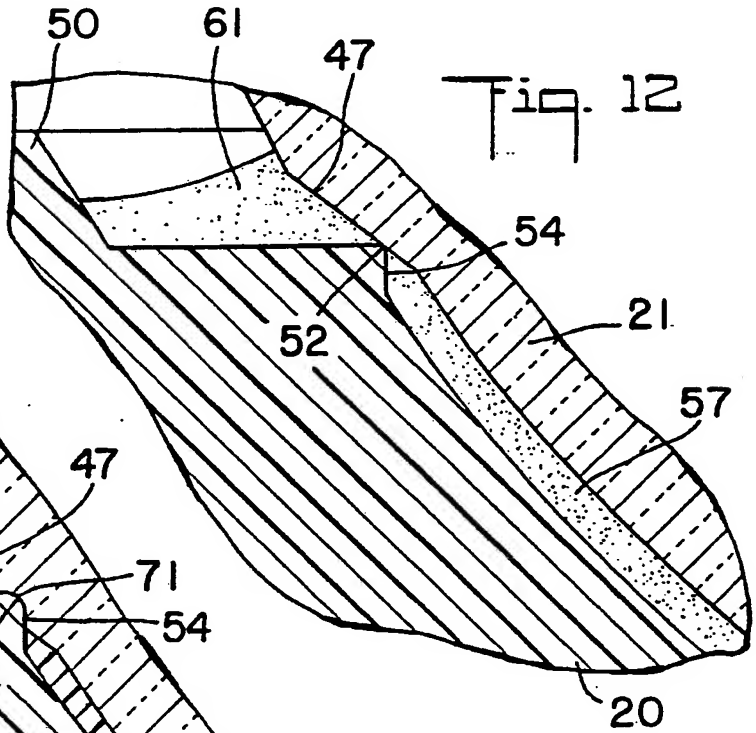


Fig. 12



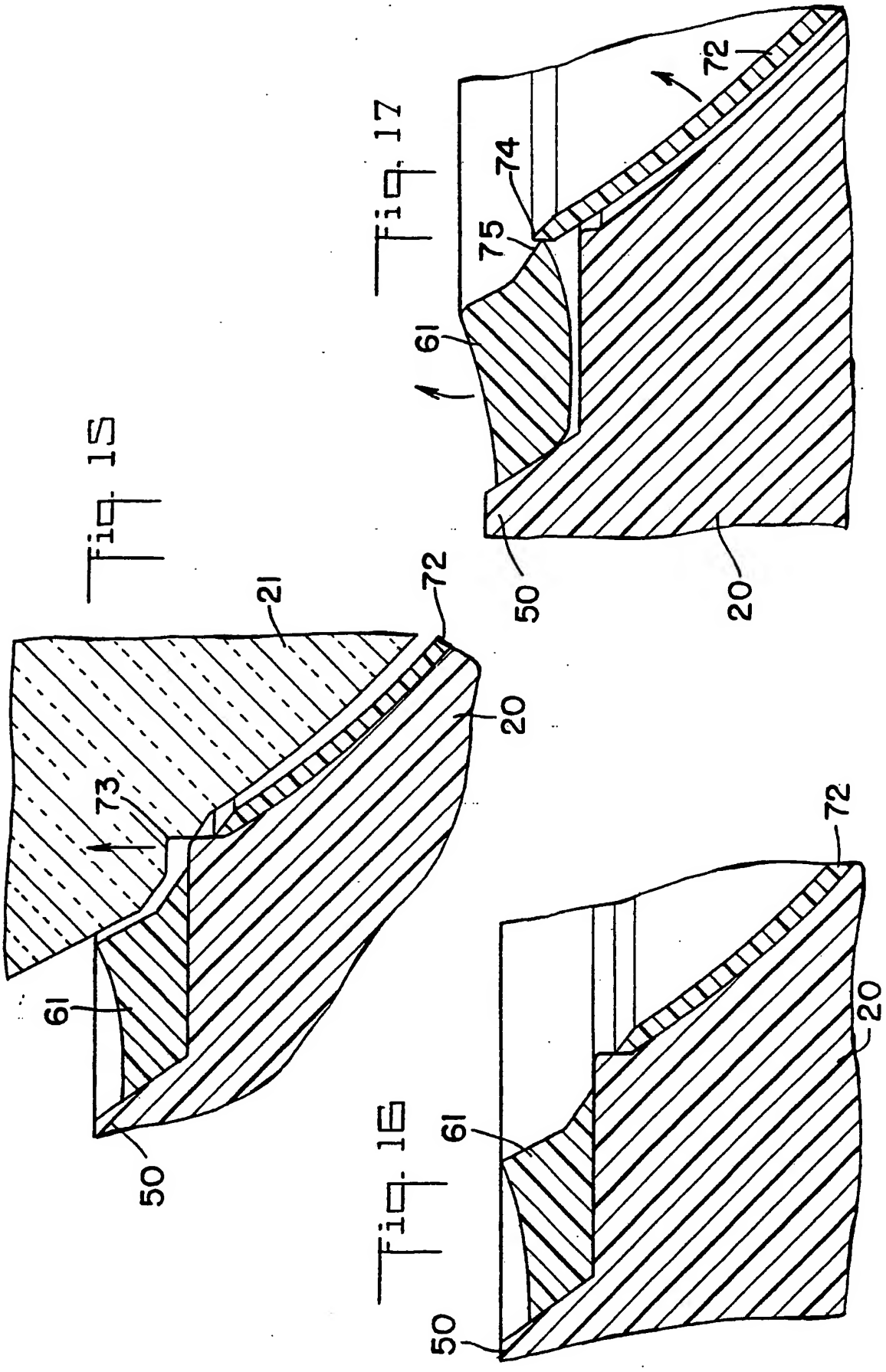


Fig. 17
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Fig. 15
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Fig. 16
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Fig. 18

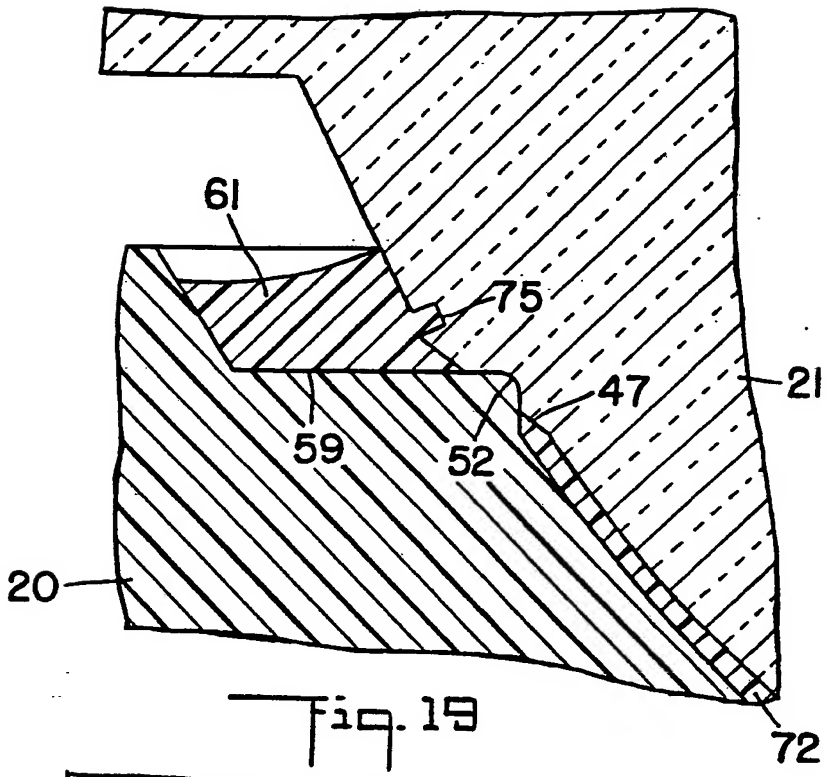
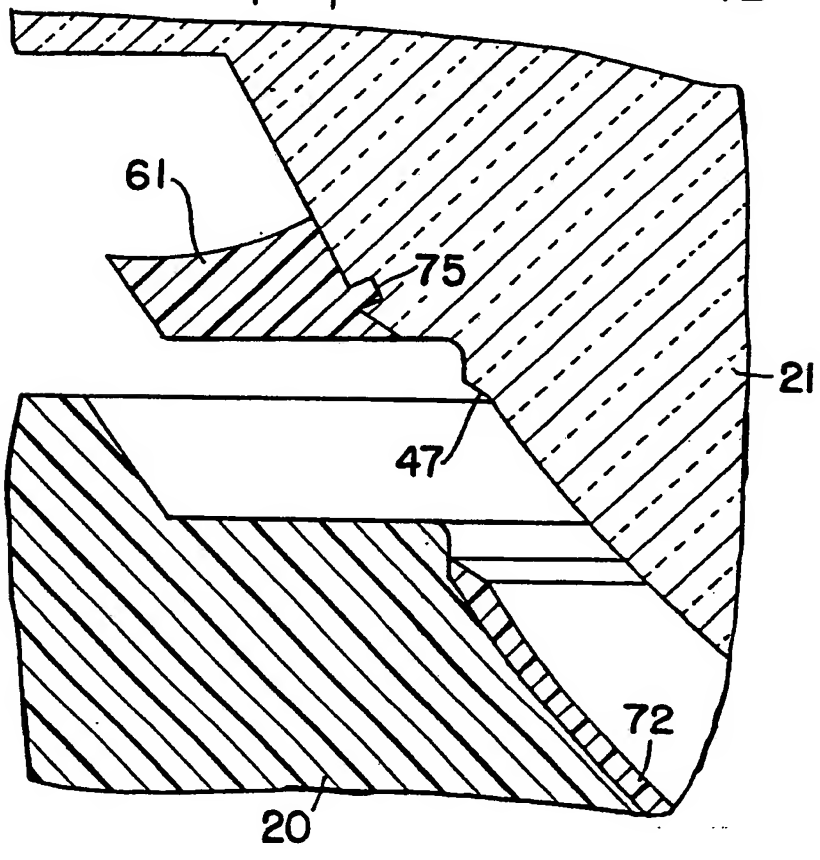


Fig. 19



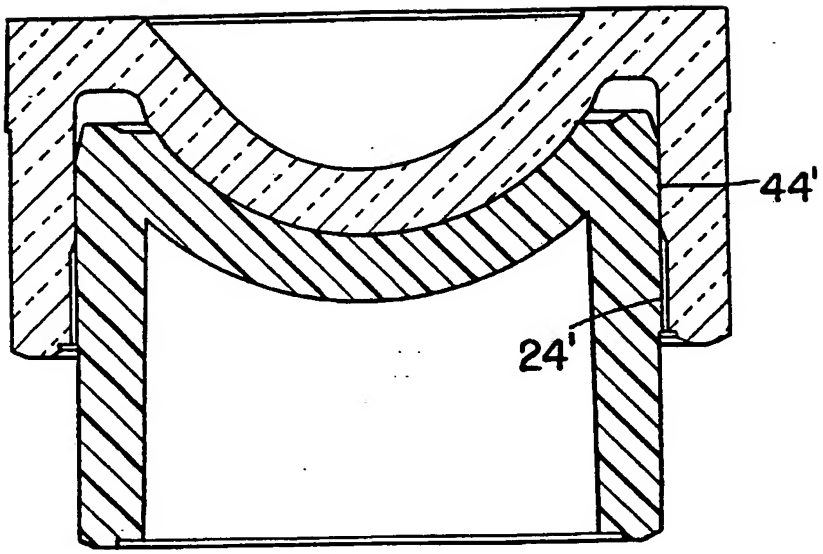


Fig. 20

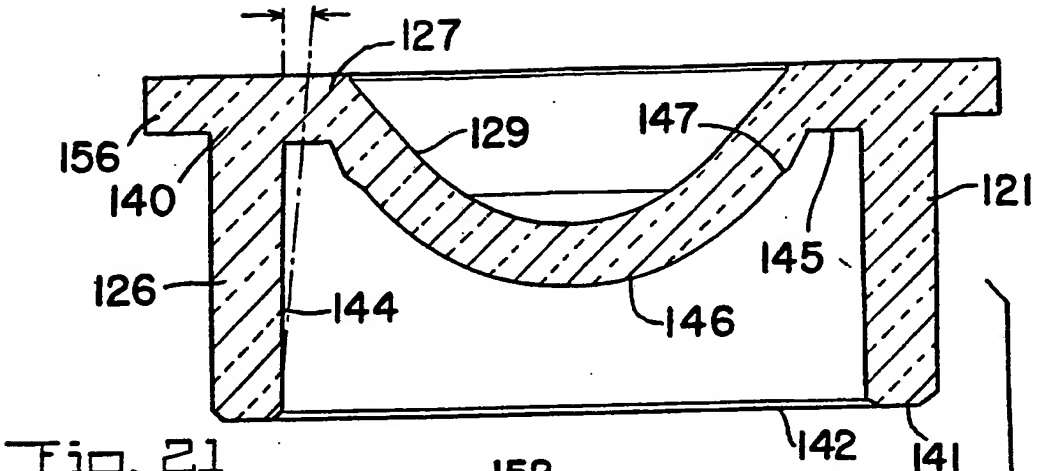

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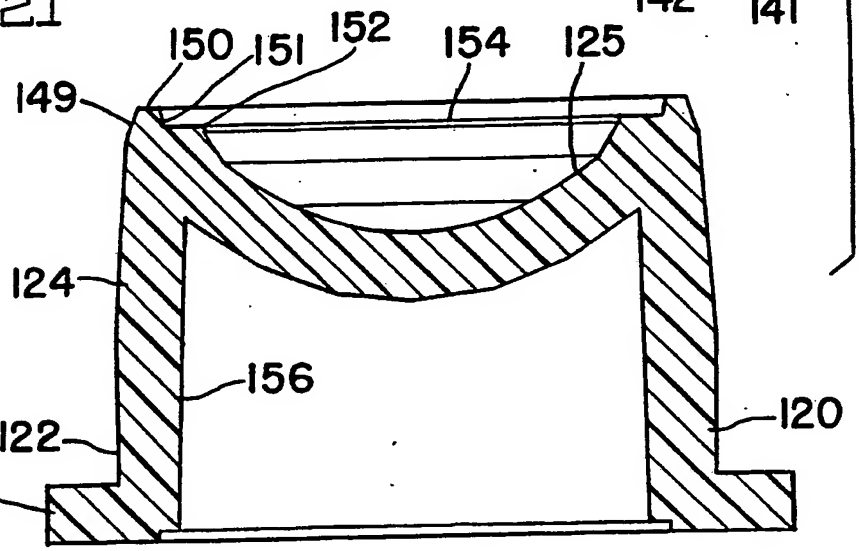
Fig. 21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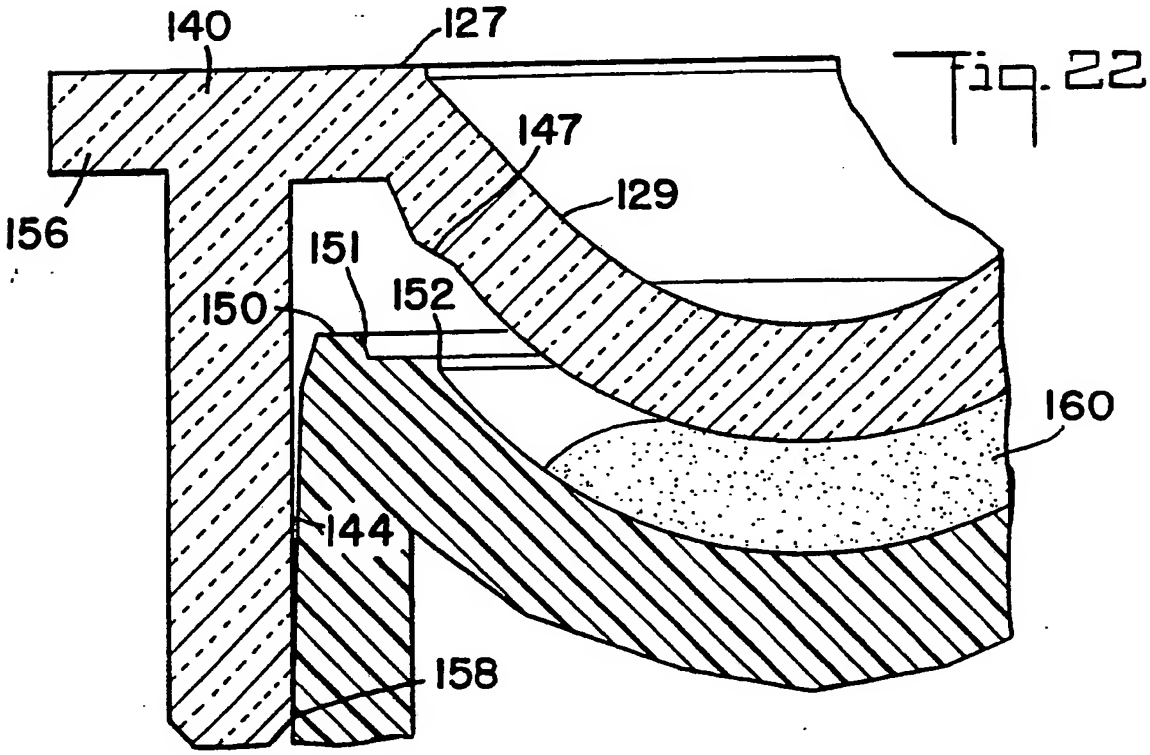
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Fig. 22

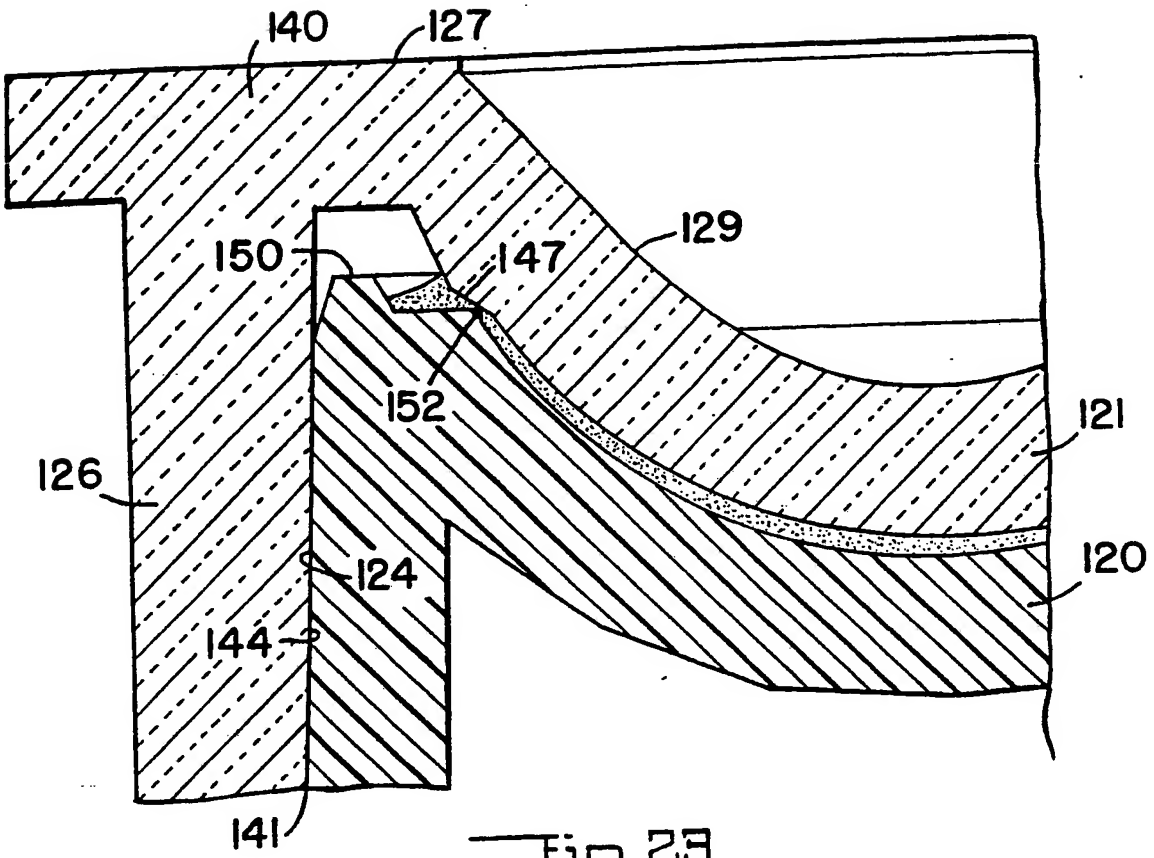
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Fig. 23

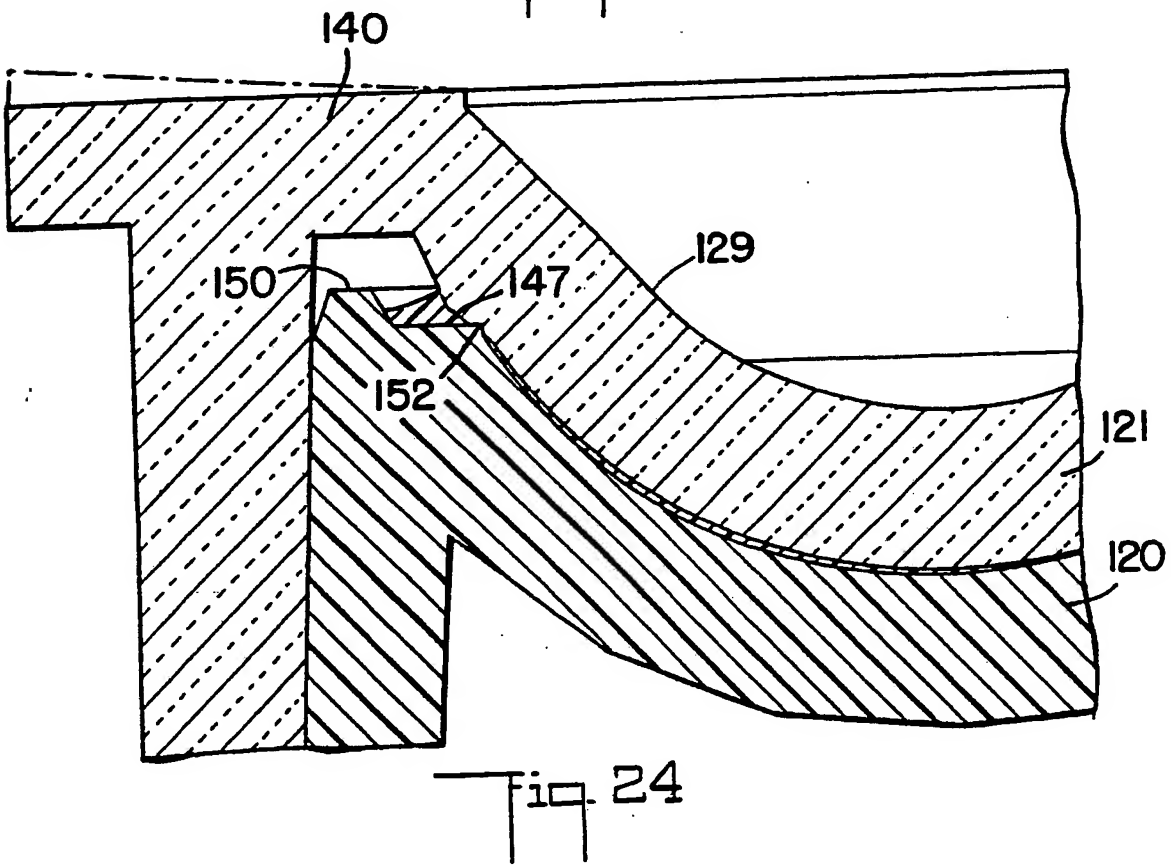
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Fig. 24

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 92/07243

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B29D11/00; B29C33/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B29D ; B29C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	GB,A,2 235 408 (M.J.S.SCIENTIFIC LTD.) 6 March 1991 see page 4, line 15 - page 4, line 27; figure 5 ---	1-70
A	US,A,4 197 266 (CLARK,LIVESEY,WRUE) 8 April 1980 cited in the application ---	1,20,29, 35,54
A	EP,A,0 064 381 (BAY) 10 November 1982 cited in the application ---	1,20,29, 35,54
A	US,A,4 865 779 (IHN,BOUGHTEN) 12 September 1989 ---	1,20,29, 35,54
A	FR,A,2 402 525 (TORAY INDUSTRIES) 6 April 1979 ---	1,20,29, 35,54
	-/--	

° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
01 DECEMBER 1992	21. 01. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	ROBERTS P.J.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	FR,A,2 565 160 (ESSILOR INTERNATIONAL) 6 December 1985 ---	1,20,29, 35,54
A	EP,A,0 383 425 (GALLEY) 22 August 1990 ---	1,20,29, 35,54
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9207243 SA 64534

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